Name of Organization: University of Iowa

Type of Organization: College or University

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Project Title: Persistent Toxic Substances in Lake Michigan Sediments

Project Category: Emerging Issues

Rank by Organization (if applicable): 0

Total Funding Requested ($): 231,500 **Project Duration:** 2 Years

Abstract:

Two monitoring campaigns in Lake Michigan have recently been undertaken in support of large-scale modeling efforts: the Lake Michigan Mass Balance (LMMB) and Episodic Events-Great Lakes Experiment (EEGLE). Samples were collected on finely resolved temporal and spatial scales from different media (air, water, sediment). The LMMB focussed its sampling efforts around providing supporting data for a whole-lake modeliing effort of persistent bioaccumulating toxic substances (PBTSs) in Lake Michigan while EEGLE field sampling focuses its efforts on monitoring the effects of an early-spring, storm-induced sediment resuspension event in the southern basin. The goal of EEGLE is to better understand the effect of this resuspension event on PBTS fate and transport. Sampling campaigns were undertaken in 1998 and 1999, before, during, and after the event during which samples were collected in the air, water, and on settling particles. Clearly, the issues to be addressed by EEGLE are a subset of the LMMB. Since such great effort was placed in collecting, analyzing, and organizing field samples and data, little has been done to sort through the data from either project and interpret the implications of this sediment resuspension event on the fate and transport of PBTSs in Lake Michigan. We propose the organization and interpretation of data from both projects in light of building a database from which sediment-associated chemical transport will be estimated. Additional field samples will be collected and analyzed in support of the working hypotheses proposed.

Geographic Areas Affected by the Project

States:

- [x] Illinois
- [x] Indiana
- [x] Michigan
- [ ] Minnesota
- [ ] New York
- [ ] Pennsylvania
- [x] Wisconsin
- [ ] Ohio

Lakes:

- [ ] Superior
- [ ] Huron
- [x] Michigan
- [ ] Erie
- [ ] Ontario
- [ ] All Lakes

Geographic Initiatives:

- [x] Greater Chicago
- [ ] NE Ohio
- [x] NW Indiana
- [ ] SE Michigan
- [ ] Lake St. Clair

Primary Affected Area of Concern: Not Applicable

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Not Applicable

Other Affected Biodiversity Investment Areas:

Problem Statement:

During the 1990's, two lake-wide monitoring projects were undertaken in the Lake Michigan region: the Lake Michigan Mass Balance (LMMB) study and Episodic Events-Great Lakes Experiment (EEGLE). For both projects, samples were collected in many media (i.e., air, water, and sediment) on a finely time resolved basis. This has resulted in a wealth of data that has yet to be interpreted for its potential impact on cycling of persistent bioaccumulting toxic substances (PBTSs), which includes polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trans-nonachlor, and atrazine. While the focus of the LMMB was to model the behavior of PBTSs on a whole-lake basis, the focus of EEGLE was to investigate the effect of a springtime, wind-induced sediment resuspension event on southern Lake Michigan. The LMMB data, together with data already collected for EEGLE and a few additional sediment-targeted sampling efforts, the following hypothesis about PBTS cycling in Lake Michigan will be addressed.

Our first hypothesis is that surficial sediment from the western side of Lake Michigan is clean with respect to PBTSs. Sediment on this side of the lake is the result of erosion from the surrounding shoreline and contains small amounts of PBTSs. A corollary to this hypothesis is that resuspension of clean surficial sediment will induce local atmospheric deposition of PBTSs.

Our second hypothesis is that surficial sediment from the southern end of Lake Michigan, near the Chicago-Gary industrial complex, is highly contaminated with respect to PBTSs. Sediment in this region of the lake is the result of tributary and atmospheric deposition of particulate material highly contaminated with PBTSs. A corollary hypothesis is that resuspension of dirty surficial sediment has two results. First, there is no net change in PAHs due to a portion, which is unexchangibly bound to particles, resulting in their permanent burial. Second, PCBs are introduced into the water column, resulting in a source to Lake Michigan.

Proposed Work Outcome:

We propose merging PBTS data from the LMMB and EEGLE to form a large organized and interpreted collection of data from which a sediment fate and transport model will be constructed. We propose the following four areas on which we will focus our efforts to address our hypotheses.

First, we will gather and organize PBTS data from both the LMMB and EEGLE studies to fill the spatial and temporal data gaps caused by the sampling schemes of both projects. Significant effort has been put into the collection and chemical analysis of sediment samples, resulting in an immense amount of data for which resources have not been allocated for it to be evaluated and interpreted. The EPA needs to know how data resulting from samples collected by EEGLE compare with data from the LMMB sampling campaign. This effort will result in two deliverable products. The first product will be a quality control (QC) summary of all relevant data from both sources similar to those previously completed (ref. 1-4). The second product will be a summary of all the relevant data from both sources charting spatial and temporal variation (ref. 1, 5-6)

Second, we will chemically analyze additional field samples to characterize readily resuspendable sediment. Approximately eighteen samples of readily resuspendable sediment will be collected between March and May 2000 as part of the final field sampling campaign for EEGLE. While funding for this spring 2000 collection of readily resuspendable sediment samples is provided by GLNPO through February 2001 for EEGLE, funding is not currently available to chemically analyze these valuable samples. Historically, sediments have been characterized using box cores and settling sediment traps. There has been no other work to chemically characterize sediment prior to its resuspension. The data resulting from this proposed field sampling effort will be used to evaluate our first hypothesis.

Third, all data from the LMMB, EEGLE, and readily resuspendable sediment will be used to model local exchange process (i.e., water-sediment and air-water exchange) on a temporal basis. Preliminary results from EEGLE indicate that resuspended sediments are clean with respect to PBTSs relative to the bulk water, which causes a net deposition of gas-phase PBTSs to Lake Michigan. Funding is not currently available from any other source to perform this proposed modeling effort.

Lastly, we will couple our temporally resolved exchange results with sediment transport models and atmospheric modeling efforts currently underway. We intend to develop an understanding of temporally resolved sediment-water interactions on a spatially resolved basis especially with respect to large storms and sediment resuspension events. This level of modeling effort is not funded under the current GLNPO funding.

1. Miller, S.M. (1999). "Spatial and Temporal Variability of Organic and Nutrient Compounds in Atmospheric Media Collected During the Lake Michigan Mass Balance Study." M.S. Thesis, State University of New York at Buffalo, Buffalo, NY.

2. Miller, S.M., Sweet, C.W., DePinto, J.V., and Hornbuckle, K.C., (2000). "Atrazine and Nutrients in Precipitation: Results from the Lake Michigan Mass Balance Study." Environmental Science and Technology, 34(1): 55-61.

3. Miller, S.M., Green, M.L., DePinto, J.V., and Hornbuckle, K.C., (In Review). "Results from the Lake Michigan Mass Balance Study: Concentrations and Fluxes of Atmospheric Polychlorinated Biphenyls and trans-Nonachlor at Twenty Sites Around Lake Michigan." Environmental Science and Technology.

4. Miller, S.M. and Hornbuckle, K.C., (In Review). "Anomalous Gas-phase Polychlorinated Biphenyl Concentrations at Beaver Island, MI." Environmental Science and Technology.

5. Bogdan, J.J. (1999). "A Study of the Cycling of Organic Contaminants in Air and Water: The Pilot Year of the Episodic Events - Great Lakes Experiment (EEGLE) Project." M.S. Thesis, State University of New York at Buffalo, Buffalo, NY.

6. Bogdan, J.J., Budd, J.W., and Hornbuckle, K.C., (In Preparation). "The Effect of a Large Resuspension Event in Southern Lake Michigan on the Short-term Cycling of Organic Contaminants." Environmental Science and Technology.

Project Milestones:	Dates:
Project Start	09/2000
Submit QA Project Plan	10/2000
Begin Anaysis of PBTSs	10/2000
Submit Data Review Summary	10/2001
Submit QC Summary	10/2001
End Analysis of PBTSs	10/2001
Report on Modeling Results	08/2002
Project End	08/2002

☐ Project Addresses Environmental Justice

If So, Description of How:

☐ Project Addresses Education/Outreach

If So, Description of How:

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	130,000	12,500
Fringe:	16,000	0
Travel:	4,000	0
Equipment:	0	0
Supplies:	12,000	0
Contracts:	0	0
Construction:	0	0
Other:	4,500	0
Total Direct Costs:	166,500	12,500
Indirect Costs:	65,000	0
Total:	231,500	12,500
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Hornbuckle, K.C. and Eichinger, W. E. Center for Global and Regional Environmental Research (CGRER). "Design and Installation of the Iowa Atmospheric Measurement Station (IA-AMS)." August 1999 - August, 2000. $20,000.

Hornbuckle, K.C. (PI/PD). Unversity of Iowa Carver Scientific Research Initiative Grant Program . "Stage I Planning For a Trinational Atmospheric Deposition Network for Persistent Organic Pollutants." May, 1999 - May 2000. $15,000.

Hornbuckle, K.C. (PI/PD) U.S. Environmental Protection Agency, Great Lakes National Program Office. "Study of Organic Contaminants in Air and Water in Conjunction with Episodic Events - Great Lakes Experiment." Jan. 1, 1998 to Feb 4. 2001: $364,000.

Hornbuckle, K.C. (PI/PD) National Science Foundation Faculty Early Career Development (CAREER) Program. "Dynamics of Gas-Phase Persistent Organic Chemicals: An Investigation of the Effect of Climate using a Controlled Chamber." Sept. 1, 1997 through Aug. 30, 2001: $200,000.

Hornbuckle, K.C. (PI/PD); DePinto, J.V.(PI) U.S. Environmental Protection Agency, Great Lakes National Program Office. "Atmospheric Loading of PCBs, Trans-nonaclor, Atrazine, Nitrogen and Phosphorous to Lake Michigan." Oct. 1, 1996 to Sept 30, 2000: $251,000.

Description of Collaboration/Community Based Support:

Dr. Hornbuckle is an assistant professor in the Department of Civil and Environmental Engineering at the University of Iowa. She is affiliated with the Center for Global and Regional Environmental Research (CGRER) and the Iowa Institute for Hydraulic Research (IIHR), both at the University of Iowa. Prior to her arrival at the University of Iowa in 1998, she was an assistant professor in the Department of Civil, Structural and Environmental Engineering at the State University of New York at Buffalo. Dr. Hornbuckle has been involved in Great Lakes air toxics research since working on the Green Bay Mass Balance project starting in 1989. She has published fifteen peer-reviewed papers on air/water exchange and air/terrestrial exchange of air toxics (PAHs, PCBs and other chlorinated organics) and has presented work to universities, public groups, international agencies, and industry on numerous occasions.

Dr. Hornbuckle is an active member of the International Joint Commission's (IJC) Science Advisory Board and a liaison to the IJC's International Air Quality Advisory Board. Her awards include the National Science Foundation's CAREER award for young investigators, a best paper award from the Environmental Chemistry Division of the American Chemical Society, and the IAGLR/Mott fellowship for PhD work. She received her B.A in chemistry from Grinnell College (1987) and her Ph.D. in Civil Engineering from the University of Minnesota (Minneapolis, 1996). Dr. Hornbuckle currently advises six graduate students.